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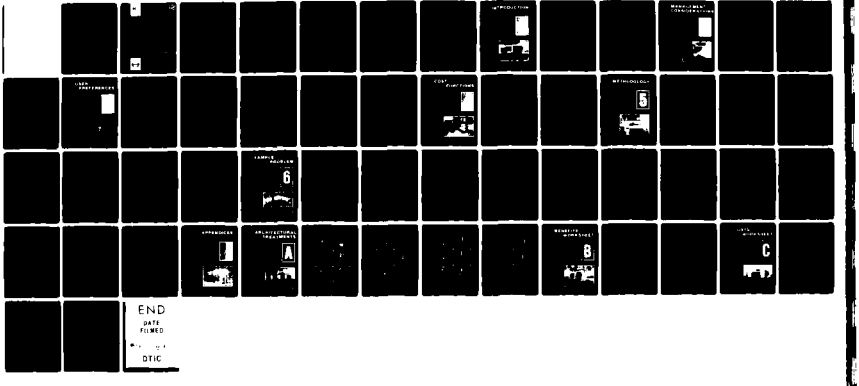

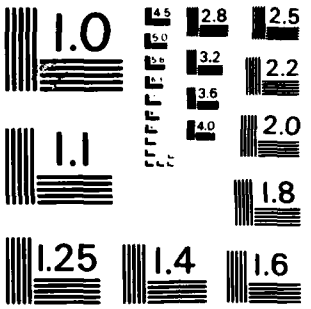

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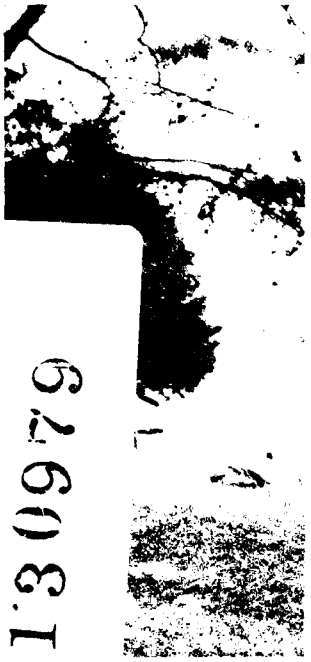

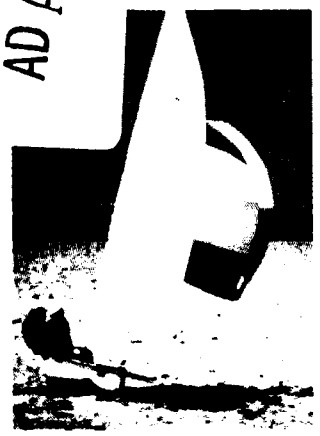

ENVIRONMENTAL LABORATORY

RECREATION RESEARCH PROGRAM

INSTRUCTION REPORT R-83-1

COMPUTING COST-EFFECTIVENESS OF ALTERNATIVE SANITARY FACILITIES

by

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March 1983
Final Report

pared for Office, Chief of Engineers, U. S. Army
Washington, D. C. 20314

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REPORT DOCUMENTATION PAGE	READ INSTRUCTIONS BEFORE COMPLETING FORM
1. REPORT NUMBER Instruction Report R-83-1	2. GOVT ACCESSION NO. A130979
3. RECIPIENT'S CATALOG NUMBER	
4. TITLE *(and Subtitle)* COMPUTING COST-EFFECTIVENESS OF ALTERNATIVE SANITARY FACILITIES	5. TYPE OF REPORT & PERIOD COVERED Final report
	6. PERFORMING ORG. REPORT NUMBER
7. AUTHOR(s) Michael R. Waring, Ronald W. Hodgson, Thomas M. Walski, Anita K. Lindsey	8. CONTRACT OR GRANT NUMBER(s)
9. PERFORMING ORGANIZATION NAME AND ADDRESS U. S. Army Engineer Waterways Experiment Station Environmental Laboratory P.O. Box 631, Vicksburg, Miss. 39180	10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS Recreation Research Program
11. CONTROLLING OFFICE NAME AND ADDRESS Office, Chief of Engineers, U. S. Army Washington, D. C. 20314	12. REPORT DATE March 1983
	13. NUMBER OF PAGES 51
14. MONITORING AGENCY NAME & ADDRESS*(if different from Controlling Office)*	15. SECURITY CLASS. *(of this report)* Unclassified
	15a. DECLASSIFICATION/DOWNGRADING SCHEDULE

16. DISTRIBUTION STATEMENT *(of this Report)*

Approved for public release; distribution unlimited.

17. DISTRIBUTION STATEMENT *(of the abstract entered in Block 20, if different from Report)*

18. SUPPLEMENTARY NOTES

Available from National Technical Information Service, 5285 Port Royal Road, Springfield, Va. 22151.

19. KEY WORDS *(Continue on reverse side if necessary and identify by block number)*

Cost effectiveness
Recreation
Recreational facilities
Sanitary engineering
Sewage disposal

20. ABSTRACT *(Continue on reverse side if necessary and identify by block number)*

'Sanitary facilities at Corps of Engineers recreation areas contribute significantly to the total cost for both construction and operations and maintenance. In many cases, these costs appear to be unrealistic and the resultant facilities not cost-effective. This is especially true when the facilities are either overdesigned or underdesigned for the level of development or visitation of the area.

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Unclassified

SECURITY CLASSIFICATION OF THIS PAGE *(When Data Entered)*

20. ABSTRACT (Continued).

This lack of cost-effectiveness can be partially attributed to the lack of any formal methodology that incorporates visitor preferences, by which the planner or designer can quickly evaluate a number of alternative design parameters very early in the development or rehabilitation of a recreation area. The methodology presented in this report addresses this problem through not only the actual costs, but also the visitor preferences and management considerations.

A sample problem is included to illustrate one way in which the methodology may be used.

PREFACE

This report presents a methodology for determining cost-effective sanitary facilities at Corps of Engineers recreation areas. The report was completed as a part of Work Unit 31694, Planning and Design Criteria for Recreation Roads and Sanitary Facilities. An in-house technical report was also prepared detailing the study and results.

Authors of this report were Mr. Michael R. Waring, Mr. Ronald W. Hodgson, Dr. Thomas M. Walski, and Ms. Anita K. Lindsey, Environmental Laboratory (EL), U. S. Army Engineer Waterways Experiment Station (WES), Vicksburg, Miss. Mr. Waring was Principal Investigator and was on temporary assignment under the terms of an Intergovernmental Personnel Act (IPA) Agreement between WES and Texas A&M University, College Station, Tex. Dr. Hodgson was on an IPA agreement between WES and California State University, Chico, Calif. Waring and Hodgson were members of the Resource Analysis Group of the Environmental Resources Division (ERD). Dr. Walski and Ms. Lindsey were members of the Water Resources Engineering Group of the Environmental Engineering Division.

Dr. Adolph J. Anderson, EL, was Program Manager for the Recreation Research Program. The study was under the supervision of Dr. Conrad J. Kirby, Chief, ERD, and Dr. John Harrison, Chief, EL.

Commanders and Directors of WES for the period of the study and report preparation were COL Nelson P. Conover, CE, and COL Tilford C. Creel, CE. Technical Director was Mr. F. R. Brown.

This report should be cited as follows:

> Waring, M. R., et al. 1983. "Computing Cost-Effectiveness of Alternative Sanitary Facilities," Instruction Report R-83-1, U. S. Army Engineer Waterways Experiment Station, CE, Vicksburg, Miss.

CONTENTS

INTRODUCTION

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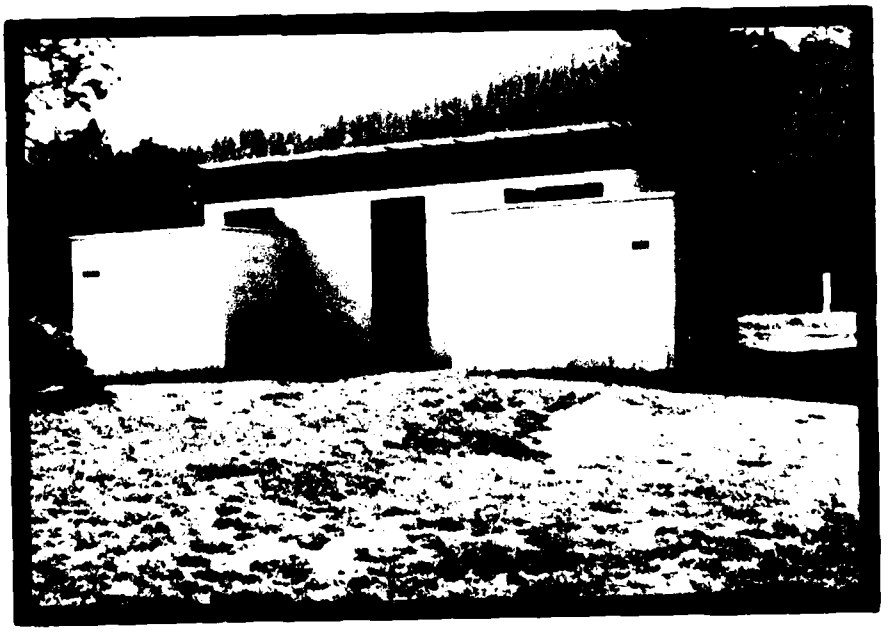


COMPUTING COST-EFFECTIVENESS OF ALTERNATIVE SANITARY FACILITIES

INTRODUCTION

1.1 Recreation at Corps lakes and waterways has grown from an incidental amenity to a major program that caters to the needs of millions of leisure-seeking people. In 1981, over 468 million recreation days of use were reported at the 454 Corps lakes and lock-and-dam projects that have significant visitation.

1.2 Roads and sanitary facilities at these projects represent a substantial investment in terms of both initial construction cost and subsequent operations and maintenance costs. These facilities are not cost-effective when they are either overdesigned or underdesigned in terms of numbers, size, or level of development. This is especially true when the facilities fail to respond to the appropriate level of visitor expectations and/or actual needs.

1.3 Corps of Engineers personnel are often required to make decisions on level of development, size, and type of facility without the benefit of any formalized methodology that incorporates visitor preferences. This lack of a formal methodology, especially early in the planning progress, has resulted in many facilities that are excessively costly and overdesigned for the type of area and visitor they serve.

Background

1.4 The original concept for this work unit was an investigation into various aspects of both roads and sanitary facilities, including visitor preferences, innovative/alternative materials and designs, cost functions, and management constraints and opportunities. Results obtained early in the study indicated that the major emphasis should be placed on sanitary facilities. Additional research indicated that the innovative/alternative portion of the sanitary facilities should not be emphasized.

Purpose

1.5 This manual provides the Corps planner and/or designer with a methodology for evaluating various sanitary facility alternatives to determine their cost-effectiveness. It is not intended to give the user a specific design solution, but rather a range of alternative parameters within which to design. It should be noted that this is a very general methodology; it can and should be adapted to specific regional or area requirements.

Key terms

1.6 Key terms used herein are defined below:

Architectural Treatment - The materials and general style of design used for both the interior and the exterior of the sanitary facility. Illustrations of the general treatments used in his study are found in Appendix A.

Cost-Effective - A facility is cost-effective if the additional benefits that visitors experience from the facility exceed the additional cost of providing the facility.

Day Use Area - A designated recreation area or portion of an area in which no camping is permitted.

High Development Campground - A campground in which the level of development of facilities is approximately equal to the Corps of Engineers classifications A and B. These would have sanitary disposal stations and vault or flush toilets.

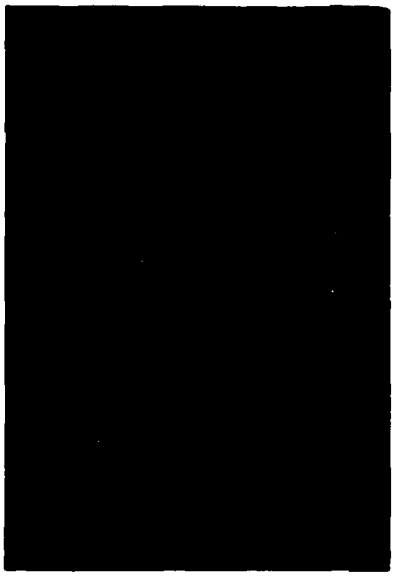
Low Development Campground - All campgrounds that are not classified as high development.

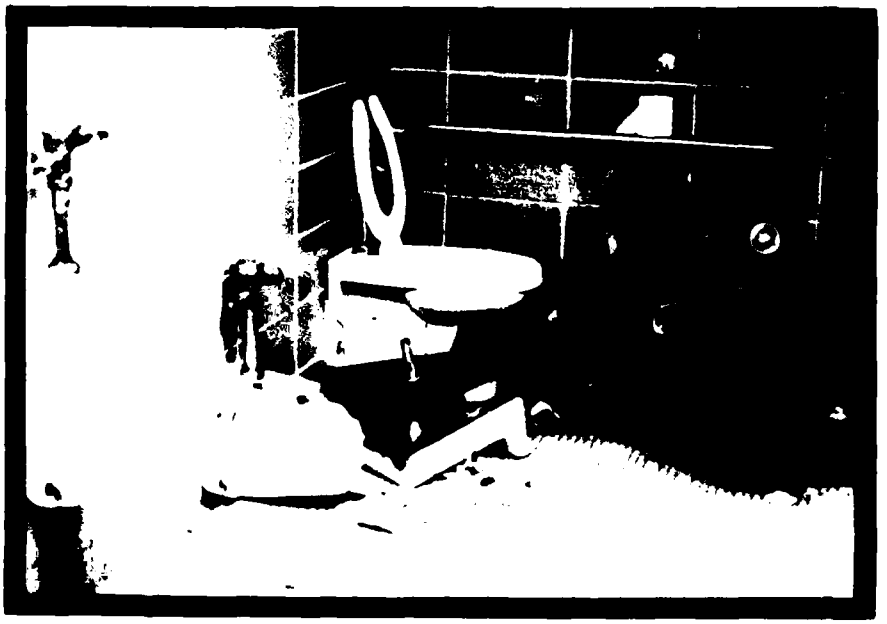
Party Day - A party day is a party using an area for all or part of a 24-hr day. A party is composed of those people traveling or staying together at the recreation area. In the case of campgrounds, this is the group of people occupying one campsite.

Vault-Type System - A vault system is any nonwaterborne system, including pits, portable toilets, and pump-out systems.

Waterflush System - Any system (including chemical flush) in which waste is carried from a flush toilet to a waste treatment system. Waterflush systems can include additional fixtures such as showers and washbasins.

MANAGEMENT CONSIDERATIONS





MANAGEMENT CONSIDERATIONS

2.1 Planners and designers are often faced with a myriad of considerations during the planning, design, and construction of recreation area sanitary facilities. These considerations include both constraints and opportunities that can affect any of the phases of providing sanitary facilities. The purpose of this section is to discuss the effects of both constraints and opportunities on the cost-effectiveness of sanitary facilities.

Constraints

2.2 Constraints to providing sanitary facilities include, but are not limited to, health and safety regulations, directives from higher headquarters, site characteristics, maintenance limitations, and visitor behavior. The planner or designer may have very little latitude with some of these constraints, e.g., the health regulations and directives, since these often represent "concrete" parameters within which sanitary facilities must be planned. However, the site, maintenance, and visitor characteristics are much less concrete in nature and should be considered in the planning and design process.

2.3 Site. Some of the first constraints that must be considered are those associated with the site. These include actual site characteristics such as soil, slope, topography, and location of the site with respect to community water supplies and treatment plants. Site constraints can greatly affect the cost of the sanitary facility since they may influence the type of facility (waterborne versus vault) and treatment options available. For example, if the site is located a great distance from a community treatment plant, the planner may be faced with the possibility of treating the wastewater on site or installing only vault systems that must be pumped out. These site characteristics can affect the selection and cost throughout the planning and design process.

2.4 Maintenance and visitor behavior. Additional constraints to be considered by the planner/designer are type and amount of maintenance and visitor behavior, especially vandalism and pest complaints. Two things should be noted with regard to these constraints. First, a recent visitor survey indicated that visitor preferences are based on an assumption of clean sanitary facilities--the value of a particular sanitary facility drops to zero or near zero if the facility is not clean. Second, a survey of Corps projects indicated that properly maintained facilities are a major deterrent to vandalism. The cost-effectiveness of a sanitary facility is closely related to both of these issues. A well-maintained facility can reduce the replacement cost due to vandalism and at the same time increase overall visitor satisfaction.

2.5 Another consideration is that of "vandal-resistant" fixtures. In many cases, the initial cost is much higher than for standard fixtures. When these fixtures must be replaced, they are often hard to locate and are once again very costly. It may be more cost-effective to use standard fixtures that are readily available and cheaper to replace.

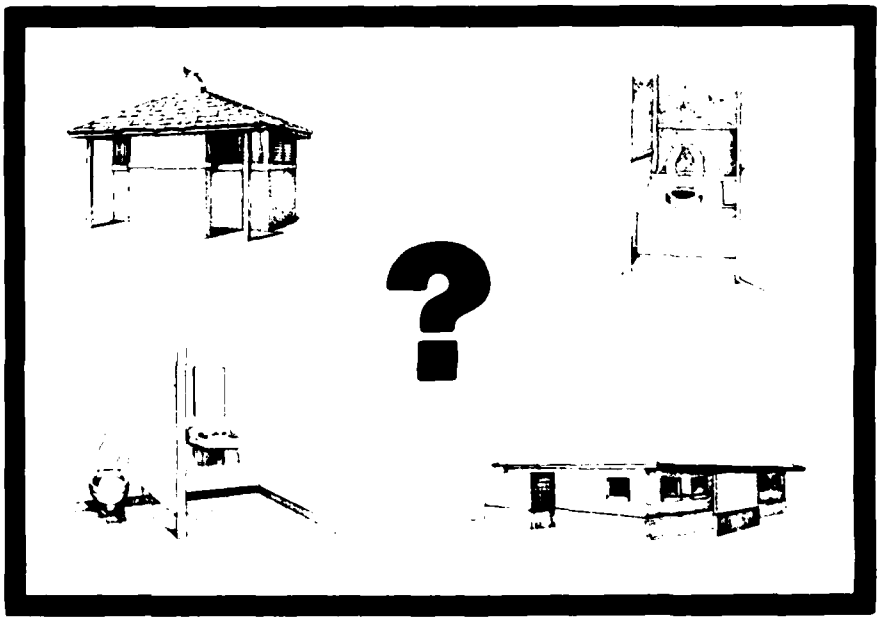
Opportunities

2.6 Major opportunities for cost-effective sanitary facilities may be provided by innovative or alternative designs and treatment systems. A survey of Corps Districts indicated that while some innovative/alternative systems are in use, their use and acceptance are not widespread. Predominant innovative/alternative systems that are now being tried at various projects include solar power, low flow, oil flush, and composting type facilities. These have met with varying degrees of success, with the oil flush system presenting the majority of the problems. However, many of these systems can provide the planner/designer with a cost-effective solution where conventional systems may not work. For example, composting systems may be a cost-effective alternative in remote, highly used areas where water supply and wastewater treatment are not feasible and where a standard pit or vault toilet would be undesirable because of the level of use or the pump-out cost

Summary

2.7 All management constraints and opportunities should be considered by the planner/designer when evaluating alternatives for the recreation area. The methodology presented later in this manual does not address these areas specifically, but they are very much a part of the process.

USER PREFERENCES



USER PREFERENCES FOR LEVELS OF DEVELOPMENT IN SANITARY FACILITIES

3.1 Buildings and fixtures can be provided at several levels ranging from a pit or vault-type toilet to a comfort station equipped with toilets, wash basins, laundry sinks, and showers. Architectural treatments, both interior and exterior, can range from very simple to elaborate. Many users prefer the more elaborate to the simpler facility. However, costs of providing sanitary facilities increase as the buildings and fixtures become more elaborate. The problem is to determine the level of development beyond which the worth of the improvements to the users is exceeded by the cost of providing them.

3.2 One measure of the worth of those facilities is a user's willingness to pay for the facilities. A variation of the Contingent Valuation Method (CVM)* was used in a visitor survey to isolate the value of sanitary facilities within the recreation experience and to evaluate the relative values of different fixture combinations and levels of architectural treatment. The survey was conducted during the 1981 recreation season (May-September) at Dworshak Reservoir, Greer's Ferry Lake, Hartwell Lake, McNary Dam and Reservoir, Lake Shelbyville, and Shenango River Lake. A random sample was taken at each project, resulting in 1363 total respondents in the survey.

3.3 Values for sanitary facilities were determined for both campers and day users. Campers were willing to pay significantly more for sanitary facilities ($p \leq 0.001$) than were day users. Values for campers were further divided by the class of campground in which they were interviewed. Campers in more highly developed campgrounds were willing to pay significantly more than those sampled in less developed areas ($p \leq 0.001$). Finally, the type of facility preferred made a difference. Those who preferred waterflush were willing to pay significantly more than were those who preferred a vault-type facility ($p \leq 0.001$).

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* Federal Register, Vol 44, No. 242, p 72,958.

3.4 Other visitor characteristics that were measured included age, sex, group size, length of stay, group type, and primary activities for the trip. However, none of these characteristics were significantly related to the visitor's willingness to pay for sanitary facilities.

3.5 User preferences for sanitary fixtures are reported in two ways: the percent of respondents indicating they want the fixture or treatment, and the dollar value of the fixture or treatment to one thousand user groups per day. Table 3.1 shows the percent of the respondents desiring a waterflush versus a vault system, both as a whole and by types of camping equipent.

TABLE 3.1: VISITOR PREFERENCES FOR WATERFLUSH VERSUS VAULT (IN PERCENT)

	High Development		Low Development		Day Use	
	Waterflush	Vault	Waterflush	Vault	Waterflush	Vault
All respondents	96	4	52	48	83	17
Tents	95	5	53	47	Not applicable	
Campers/Tent trailers	97	3	83	17	Not applicable	
Motor homes/ Travel trailers	96	4	100	0	Not applicable	

3.6 These preferences are further broken down by fixture type and architectural treatment* in Table 3.2, according to the type of campground or day use area in which the respondent was surveyed and the type of equipment used. If a respondent's party used more than one type of equipment, the most self-contained type was recorded. Note that percentages shown for the toilets represent the percent preferring a waterflush versus a vault, while the percentages shown for the fixtures (e.g., shower, architectural treatment) are for having versus not having the fixture.

* See Appendix A for examples of differing architectural development levels.

TABLE 3.2: PERCENTAGES OF RESPONDENTS PREFERRING EACH FIXTURE AND ARCHITECTURAL TREATMENT BY TYPE OF AREA AND EQUIPMENT TYPE USED

Fixture/ Architectural Treatment	High Development Campgrounds				Low Development Campgrounds				All Day Use Areas
	Tenters	Campers and Tent Trailers	Motor Homes and Travel Trailers	All Equipment	Tenters	Campers and Tent Trailers	Motor Homes and Travel Trailers	All Equipment	
				Waterflush System					
Fixture									
Toilet	95.1	97.1	96.0	96.1	48.7	*	*	52.1	82.5
Shower	84.8	93.7	94.6	92.4	35.9			35.4	40.6
Washbasin	74.3	87.9	82.1	86.1	43.6			43.8	70.1
Mirror	49.5	69.9	62.5	66.8	35.9			31.3	49.6
Laundry sink	34.1	33.1	39.7	35.5	15.4			12.5	11.5
Interior treatment									
Low option	55.4	61.5	60.7	58.6	20.5			20.8	54.3
High option	35.2	31.0	36.6	33.8	12.8			14.6	35.5
Exterior treatment									
Low option	66.5	64.4	64.7	63.9	20.5			18.8	59.4
High option	27.6	27.1	31.7	28.2	12.8			16.7	30.3
				Vault System					
Fixture									
Toilet	4.9	2.9	4.0	3.9	51.3			47.9	17.5
Interior treatment									
Low option	2.6	1.6	1.3	1.9	43.6			39.6	11.1
High option	2.6	1.3	2.7	2.2	5.1			6.3	6.0
Exterior treatment									
Low option	2.6	2.5	1.8	2.2	46.2			41.7	12.0
High option	2.6	0.4	2.2	1.8	2.6			4.2	5.1

* Total number of respondents in these categories was too small to produce usable estimates. Use estimates for the "All Equipment" category.

3.7 These stated preferences, however, are relatively crude measures. The percentage of users wanting a particular combination of fixtures and architectural treatments is valuable information, but fails to provide an accurate picture of the relative values of various combinations. The respondent's willingness to pay to have access to those facilities is a more precise and useful measure of their importance. This value of access for various fixtures and architectural treatments to the various kinds of users is reflected by the relative values displayed in Table 3.3. This measure combines the number who want the item with a measure of the strength of the need. The value is computed by multiplying the mean value of the fixture or treatment by the percent of respondents wanting it, then multiplying the results by 1000 (NOTE: This value assumes that, if the respondent did not "prefer" a fixture/facility, then it had a zero value). The figures represent the maximum amount that would be paid by 1000 user groups to secure access to the fixture or treatment for 1 day (and night in the case of campers). The measure is very useful because these data can be used to estimate the benefits to users of alternative sanitary facility designs; these benefits can then be compared to the costs when selecting the most appropriate alternative.

3.8 It should be noted that these values are based on an assumption of clean, well-maintained facilities. Visitors indicated that their value of the facility would be much lower (in some cases, zero) if the facility was dirty or in poor condition. This should be an important design consideration; i.e., the facility should be constructed in such a way that it is very easy to maintain.

TABLE 3.3: WILLINGNESS TO PAY FOR FIXTURES AND ARCHITECTURAL TREATMENTS PER 1000 PARTIES BY USER TYPE AND TYPE OF EQUIPMENT

Fixture/ Architectural Treatment	Tenters		Campers and Tent Trailers		Motor Homes and Travel Trailers		All Equipment Types		All Day Use Areas
	High Development	Low Development	High Development	Low Development	High Development	Low Development	High Development	Low Development	
Waterflush System									
Fixture									
Toilet	$1950	$ 945	$1912	*	$1565	*	$1816	$1135	$981
Shower	1391	398	1396		1278		1359	379	304
Washbasin	657	353	659		526		620	359	322
Mirror	248	194	342		269		320	178	144
Laundry sink	194	51	152		242		195	41	36
Interior									
Low option	55	51	68		61		59	42	38
High option	155	64	96		106		118	53	117
Exterior									
Low option	51	0	90		13		51	0	24
High option	58	26	82		76		71	20	64
Vault System									
Fixture									
Toilet	137	1230	98		143		124	1083	182
Interior									
Low option	0	26	0		1		0	20	0
High option	0	0	0		2		1	21	19
Exterior									
Low option	0	28	0		1		0	21	0
High option	4	0	0		2		2	21	10

* Total number of respondents in these categories was too small to produce usable estimates. Use estimates for the "All Equipment" category.

COST FUNCTIONS

COST OF RECREATION SANITARY FACILITIES

Introduction

4.1 In order to select sanitary facilities consistent with user willingness to pay, it is necessary for the planner/designer to accurately estimate the annual cost of providing different levels of service. Since developing a life-cycle cost estimate of sanitary facilities including water supply, comfort stations, washhouses, and wastewater disposal can be an involved task, a cost-estimating manual (Engineer Manual (EM) 1110-2-401, "Planning Level Cost Estimates and Selection of Sanitary Facilities at Recreational Areas")* was developed to give the planner a "cookbook" approach for estimating the cost of the facilities. The cost-estimating manual must be used in conjunction with this manual in order to provide an estimate of the cost of sanitary facilities that can be compared to the value for visitors.

4.2 All major components of sanitary facilities must be considered in developing cost estimates for planning reports. The components for which cost functions were developed for the cost-estimating manual include those typically found in recreation areas for a wide variety of site conditions and functional areas. By converting flow requirements and building sizes into cost estimates, the planner is able to evaluate trade-offs among alternative sanitary facilities.

Developing cost estimates

4.3 To determine costs, it is necessary to know such information as number of fixtures in a comfort station and peak flow from treatment. Equations based on a large number of existing structures in Corps of Engineers recreation areas are provided in the manual to enable the planner to relate washhouse, waterborne comfort station, and vault toilet facility sizes to the number of showers, waterborne toilets or urinals, and vault toilets. A range of sizes is given with the minimum size pertaining to simple structures and the maximum size pertaining to

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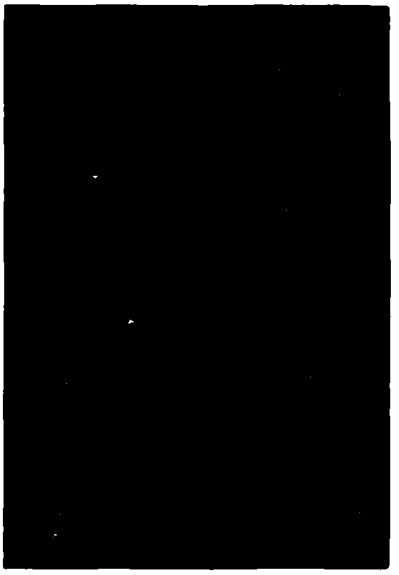
* Headquarters, Department of the Army, Washington, D. C. At this printing, EM 1110-2-401 was still in draft form.

facilities with extras such as porches, laundry rooms, service chases, etc.

4.4 Once the size and type of sanitary facility and the peak and average sanitary water use have been determined, the direct construction and operation and maintenance (O&M) cost can be calculated by inserting the values for building area or flow into the appropriate cost equation. Since cost comparisons must be made on an average annual cost basis, formulas are given in the EM to determine average annual cost from construction and O&M cost estimates. Knowing the average annual cost and expected use, it is possible to determine the unit price in dollars per user-day for sanitary facilities. These costs will be used in the manual to determine which alternatives are most cost-effective.

METHODOLOGY



METHODOLOGY FOR COMPUTING THE COST-EFFECTIVENESS OF ALTERNATIVE SANITARY FACILITY DESIGNS

Introduction

5.1 The values of various sanitary fixtures and architectural treatments determined from the user surveys are used with the facility cost estimates to compute the net benefits of alternative sanitary facility designs. The benefits to users of alternative designs can be estimated by using data in Table 5.1 to complete the worksheets in Appendix B. Costs can be computed for the same alternatives using procedures described in EM 1110-2-401, "Planning Level Cost Estimates and Selection of Sanitary Facilities at Recreational Areas" to complete the worksheet in Appendix C. The differences between benefits and costs can then be computed and the results incorporated in decision-making in the same manner as other economic data.

Procedure

5.2 Figure 5.1 shows the process that should be followed in order to determine the cost-effectiveness of sanitary facilities. Each step is essential to the overall process and applicable to both new and existing recreation areas.

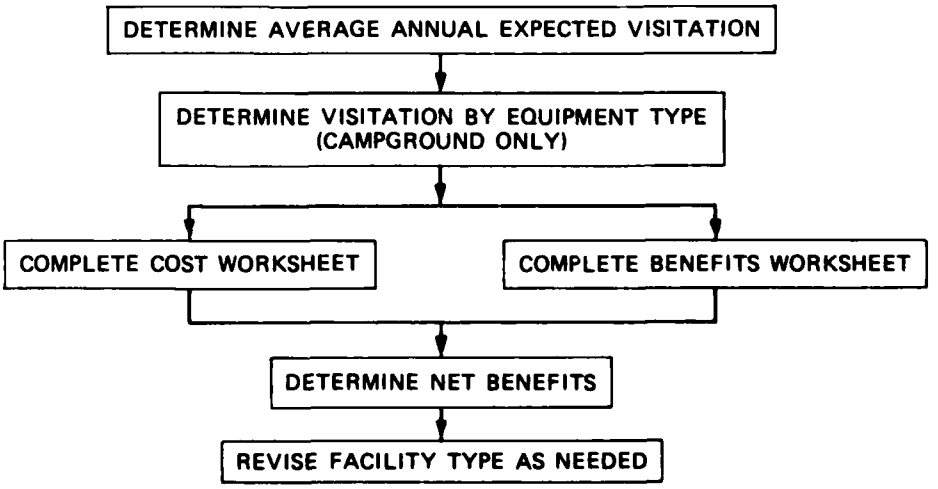


Figure 5.1. Cost-effectiveness procedure

TABLE 5.1: ADJUSTED VALUES OF FIXTURES AND ARCHITECTURAL TREATMENTS PER 1000 PARTY VISITS

Fixtures/ Architectural Treatments	High Development Campground			Low Development Campground			Day Use Areas
	Tenters	Campers and Tent Trailers	Motor Homes and Travel Trailers	Tenters	Campers and Tent Trailers*	Motor Homes and Travel Trailers*	
			Waterflush System				
Fixture							
Toilet**	2087	2010	1708	2175	2218	2218	1163
Shower	1391	1396	1278	398	379	379	304
Washbasin	657	659	526	353	359	359	322
Mirror	248	342	269	194	178	178	144
Laundry sink	194	152	242	51	41	41	36
Interior**							
Low option	55	68	62	77	62	62	38
High option	155	96	108	64	74	74	136
Exterior**							
Low option	51	90	14	28	21	21	24
High option	62	82	78	26	41	41	74
			Vault System				
Fixture							
Toilet**	2810	3170	3170	2400	2260	2260	1040
Interior**							
Low option	0	10	10	51	41	41	0
High option	0	17	17	0	43	43	109
Exterior**							
Low option	0	6	6	54	44	44	0
High option	75	54	54	0	44	44	56

* Figures in these columns are for all equipment types combined; there were too few respondents using these equipment types in less developed campgrounds to make separate value estimates.

** Values for these fixtures and treatments combine values of those preferring waterflush and those preferring vault-type systems. See paragraph 5.12 for the rationnale.

5.3 To begin the process, the average annual visitation that can be expected within the recreation area must be determined. In doing this, attention should be given to several considerations:

Is the area a campground or a day use area? If it is a campground, is it highly developed or is the development minimum?

What is your initial estimate of the number of sites?

Will the resource support the planned number and type of sites based on an analysis of the carrying capacity?

Are there any management constraints that would affect the number of sites, such as District/Division spacing guidelines?

What is the final projected visitation based on any necessary revisions in the number of sites?

It is essential that an accurate estimate of visitation be obtained since this will be used later in the process.

5.4 Once the average annual visitation has been obtained, for camping use it is necessary to determine the appropriate percentage of visitation that will occur for each type of equipment: tents, campers and tent trailers, and motor homes and travel trailers. These percentages may be based on the design itself, historical trend data, state outdoor recreation plans, or other sources of information available to the planner/designer. These will be used later in the process to determine the type of sanitary facility that should be provided.

5.5 Next, the actual costs of alternative sanitary facilities and the value of benefits of those facilities will be computed using the worksheets in Appendices B and C. Procedures contained in EM 1110-2-401 should be followed in computing actual costs of facilities. Procedures for computing benefits from the facilities are outlined in the remainder of this section.

Completing the benefits worksheets

5.6 Begin by determining whether a waterflush system or a vault system is to be evaluated. If the area is a highly developed campground, the first type of system considered should probably be a waterflush

system since figures in Table 3.2 indicate that more than 96 percent of users surveyed in more highly developed campgrounds want the waterflush as opposed to the vault system. In some situations, however, resource or other constraints may eliminate the waterflush option, and the vault-type system must be used to achieve cost efficiencies.

5.7 If the area is a low development campground, the waterflush system should again be considered since over half the users of low development campgrounds want waterflush systems. The value of a waterflush system will be higher than that of a vault system, but both types of systems should be evaluated. Large cost differences might influence the choice in these areas.

5.8 Day use area visitors want waterflush systems, but a substantial number will accept vaults. Again, both types should be routinely evaluated for day use area designs.

5.9 Use Worksheet A in Appendix B to evaluate waterflush systems for all types of areas. Complete Step 1 using the best available visitation estimates. The numbers are party days per year. A user party consists of those people traveling and staying together at the area. A party day is use of the area by one party for any part or all of a 24-hr day. If planning or use estimation survey data are available in terms of recreation days, they can be converted to party days by dividing by the average party size.

5.10 Total visitation must be broken down by user and equipment type in Step 2 of worksheet A. Three camping equipment categories are important to the estimation of benefits by this method: tents, campers and tent trailers, and motor homes and travel trailers. These equipment types represent a range of self-containment and users have different willingness-to-pay and preferences for different types of sanitary facilities. Day users are not divided by equipment type.

5.11 After the total visitation figure is multiplied by the expected percentage of use for each user and equipment type, the result must be divided by 1000. Benefit figures in Table 5.1 are per 1000 party days.

5.12 The table in Step 3 of worksheet A is completed using data from Table 5.1. First list the fixtures and levels of interior and exterior architectural treatments specified by the sanitary facility being evaluated. Then fill in the values per 1000 parties by each camping equipment type and by day use from Table 5.1. If a fixture listed is not specified in the design, leave that space blank on the worksheet for all equipment types. Note that the value for the waterflush system toilet combines the waterflush values with the vault values listed in Table 3.3. This is based on the assumption that 100 percent of the visitors would prefer at least a toilet. Those that actually prefer a vault (e.g., 4.9 percent for tenters in high development campgrounds) would be willing to pay only for a vault ($137/1000 party days) but would only accept a waterflush if offered. The values for the vault system toilets are also based on the assumption that 100 percent of the visitors would prefer a toilet. In this case, the mean value of the toilet for those preferring a vault system is multiplied by 100 percent and then by 1000. The mean value of the vault toilet is used based on the assumption that those who really prefer a waterflush system would still be willing to pay to have a toilet, but their value would not exceed the value of those preferring a vault.

5.13 The illustrations used in data collection are reproduced in Appendix A of this report and can be used to determine the level of interior and exterior architectural treatment called for by alternative designs.

5.14 Sum the values in each column. The result will be the total worth of the proposed facility to 1000 tenters (C_1), or camper/tent trailer users (C_2), or motor home/travel trailer users (C_3), or day users (C_4).

5.15 To compute the total value of the proposed sanitary facility to the users (Step 4), multiply the total worth of each equipment type or day users (numbers C_1 through C_4) by the thousands of expected visits by each equipment type and day use (numbers B_1 through B_4). Then total

these results. The sum (D_T) is the total value per year of the proposed facility to the expected users.

5.16 Use Worksheet B to compute the benefits of vault systems. The vault values in Table 5.1 are based entirely on the worth of vault systems to those who preferred vault systems. Those who preferred a waterflush system are assumed to be willing to pay the same as those who preferred vault systems for access to a vault facility. The numbers in Table 5.2 represent the value of the vault system to 1000 user parties (for 1 day).

5.17 Step 3 of worksheet B is completed in the same way as worksheet A. The value of the toilet is entered for each equipment type or day use. The level of interior and exterior treatment is determined from the design using Appendix A. Appropriate values are entered for each equipment type or day use. The values are summed and the remainder of the worksheet is completed just as for the waterflush system. The final results are used in the same way to compute net benefits which will be compared to an annual value of construction and operations and maintenance costs.

5.18 Net benefits (Step 5) are calculated by subtracting the costs (TC)* from the benefits (D_T).

5.19 Normally, the alternative design with the greatest net benefit will be preferred. Under most circumstances, negative net benefits would mean the facility should not be built. However, there is at least one situation in which negative net benefits for the facility would not rule out the facility design. That is when the recreation area could not be provided without the sanitary facility and the positive net benefits from the recreation provided by the area are great enough to compensate for the negative net benefits of the facility. For example, a recreation area is located a considerable distance from the main headquarters of the project. The location is very desirable for attracting and satisfying the needs of a large number of visitors. While not

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* To determine costs, see Appendix C worksheet.

severe enough to cause the cost of the entire recreation area to outweigh the benefits, site conditions do in fact cause the cost of the sanitary facilities to outweigh the benefits. The distance factor also adds to the cost of operating and maintaining the sanitary facility. Local, State, and Federal regulations require that sanitary facilities be provided in the recreation area. In this case, the recreation area should be provided and the planner/designer should select the sanitary facility alternative with the more favorable net benefits.

5.20 When resource constraints dictate a vault rather than a waterflush system, the planner/designer should be certain that the costs of overcoming the constraints are greater than the net benefit of the waterflush system. Most people preferred the waterflush system and would be willing to pay more for it. The choice should generally be for the design alternative with the greatest net benefit.

SAMPLE PROBLEM

	Benefits	Costs	Net Benefits
Alternative A	$ 24,000	$ 31,500	$ -7,500
Alternative B	$111,250	$110,000	$ +1,250

SAMPLE PROBLEM

Introduction

6.1 An example problem is presented in this chapter to illustrate one way that user preferences, and, hence, user benefits may be used in conjunction with cost functions to aid in the selection of cost-effective sanitary facilities. It should be noted that there are numerous other applications of this basic methodology.

Problem statement

6.2 A recreation area with 65 campsites is planned for a Corps lake. Water supply options include onsite wells or purchase from a community system 3 miles* away. Wastewater may be treated onsite or pumped to a regional system 4.5 miles away. Earlier calculations (see EM 1110-2-401) indicated that the best option was to purchase the water from the community and treat the wastewater onsite. Three washhouse/comfort station alternatives will be tested in this example.

Technical criteria

6.3 *Technical criteria include:*

a. Visitation - 39,990 recreation days/year

b. 65 campsites

c. average party size = 3.1 persons/party

d. equipment/activity mix:
- 48 percent tents
- 37 percent campers and tent trailers
- 21 percent motor homes and travel trailers
- 0 percent day users

e. Division directives require waterborne toilets

f. Recreation area is open 7 months of the year.

Alternative 1: Washhouse and comfort station, high architectural treatment

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* To convert miles to kilometres, multiply by 1.609347.

6.4 The architectural treatment used in this alternative consists of Concrete Masonry Units (CMU) with brick veneer and cedar shakes, similar to Figures 3E and 4D, Appendix A.

a. Costs. Costs for alternative 1 are summarized in Figure 6.1. These costs were calculated using methods described in EM 1110-2-401 using worksheets as in Appendix B.

b. Benefits. Worksheet A: Waterflush Systems (Appendix B) will be used to calculate the benefits to the user of alternative 1.

(1) Total visitation (A)

Total visitation in party days is calculated as follows:

Party days per year (recreation days/year) ÷ average party size = 39,990/3.1
= 12,900 party days/year

(2) Visitation by activity/equipment type (B)

Total visitation by each equipment type is calculated by

Campers (percent of total visitation) = _____ percent

B_1 = (percent tenters) (A)/1,000
= (0.48) (12,900)/1,000
= 6.192

B_2 = (percent campers and tent trailers) (A)/1,000
= (0.31) (12,900)/1,000
= 3.999

B_3 = (percent motor homes and travel trailers) (A)/1,000
= (0.21) (12,900)/1,000
= 2.709

Day Users (percent of total visitation) = ___ percent

B_4 = (percent day users) (A)/1,000
= (0) (12,900)/1,000
= 0

(3) Value per 1000 party days

The values per 1000 party days (from Table 5.1) are as follows:

Alternative No. 1

RECREATION AREA
Sanitary Facility Worksheet

	Direct Construction Cost (CC) ($)	Capital Cost (CAP) ($)	Amortized Capital Cost (AMC) ($/yr)	O&M Cost (AOM) ($/yr)	Average Annual Cost (AAC) ($/yr)
PROCUREMENT					
Water purchase	—	—	—	720	720
TRANSMISSION					
(Included with distribution)	—	—	—	—	—
TREATMENT					
	—	—	—	—	—
STORAGE					
Tank	24,561	30,701	2,462	—	2,462
DISTRIBUTION					
Force Main	50,515	63,144	5,727	190	5,917
Pump Station	11,645	14,556	1,320	162	1,482
USE					
Washhouse	111,911	139,889	12,682	9,036	21,718
comfort sta	59,490	74,362	6,741	5,899	12,640
COLLECTION					
Gravity Main	29,423	36,778	3,336	1,145	4,480
TREATMENT					
Package Plant	50,929	63,661	5,771	3,777	9,548
DISPOSAL					
	—	—	—	—	—
TOTALS	$338,474	$423,091	$38,039	$20,929	

Interest Rate 7 5/8 %

S&I ____ %

E&D ____ % } 25%

Base Year 1980

Design Life 50

Total Sanitary Cost (AAC, $/yr) $58,967 = TC

Estimated Use (USE, use-units/yr) 39,990 rec days/yr

Unit Price ($/use-unit)

Figure 6.1. Cost sheet for alternative 1

FIXTURE AND TREATMENTS	TENTERS	CAMPERS AND TENT TRAILERS	MOTOR HOMES & TRAVEL TRAILERS	DAY USERS
TOILET	$2,087	$2,010	$1,708	$ ___
SHOWER	1,391	1,396	1,278	___
WASHBASIN	657	659	526	___
MIRROR	248	342	269	___
LAUNDRY SINK	194	152	242	___
INTERIOR	155	96	108	___
EXTERIOR	62	82	78	___
TOTAL WORTH	$4,794($C_1$)	$4,737($C_2$)	$4,209($C_3$)	___(C_4)

(4) Total value per year

The total value per year is calculated as

$$D_T = (B_1 \times C_1) + (B_2 \times C_2) + (B_3 \times C_3) + (B_4 \times C_4)$$
$$= (6.192 \times \$4,794) + (3.999 \times \$4,737) + (2.709 \times \$4,209) + (0)$$
$$= \$29,684 + \$18,943 + \$11,402 + 0$$
$$= \$60,029$$

(5) Net benefits

$$B_{net} = D_T - TC$$
$$= \$60,029 - \$58,967$$
$$= \$1,062$$

A summary of all benefits for alternative 1 is provided on the benefit worksheet in Figure 6.2.

Alternative 2: Washhouse and comfort station, low architectural treatment

6.5 The architectural treatment used in this alternative consists of CMU walls and asphalt shingles, similar to Figures 3B and 4C, Appendix A.

a. Costs. Costs will remain the same except for the actual washhouse and comfort station costs. These are summarized in Figure 6.3.

b. Benefits. Benefits for alternative 2 are calculated as follows:

(1) Total visitation (A)

See paragraph 6.4b(1).

(2) Visitation by Equipment Type (B)

See paragraph 6.4b(2).

(3) Value per 1000 party days

The values per 1000 party days are:

ALTERNATIVE 1

WORKSHEET A: WATERFLUSH SYSTEMS

STEP 1. ESTIMATE TOTAL VISITATION PER YEAR

PARTY DAYS PER YEAR = 39,990 REC. DAYS ÷ 3.1 AVG. PARTY SIZE= 12,900 (A)

STEP 2. ESTIMATE VISITATION BY EQUIPMENT TYPE

TENTERS (THOUSANDS) 48 % x 12,900 (A) ÷ 1000 = 6.192 (B_1)

CAMPERS AND TENT TRAILERS (THOUSANDS) 31 % x 12,900 (A) ÷ 1000 = 3.999 (B_2)

MOTOR HOMES AND TRAVEL TRAILERS (THOUSANDS) 21 % x 12,900 (A) ÷ 1000 = 2.709 (B_3)

DAY USERS 0 % x 12,900 (A) ÷ 1000 = 0 (B_4)

STEP 3. ESTIMATE VALUE PER 1000 DAYS FOR DESIGN ALTERNATIVE BEING EVALUATED

FIXTURE AND TREATMENTS	TENTERS	CAMPERS AND TENT TRAILERS	MOTOR HOMES TRAVEL TRAILERS	DAY USERS
TOILET	# 2087	# 2,010	# 1,708	—
SHOWER	1,391	1,396	1,278	—
WASHBASIN	657	659	526	—
MIRROR	348	342	269	—
LAUNDRY SINK	194	152	242	—
INTERIOR(High)	155	96	108	—
EXTERIOR(High)	62	82	78	—
TOTAL WORTH	4,794 (C_1)	4,737 (C_2)	4,209 (C_3)	— (C_4)

STEP 4. COMPUTE THE TOTAL VALUE PER YEAR FOR THE ALTERNATIVE DESIGN BEING EVALUATED.

$B_1 \times C_1$ = # 29,684 = (D_1)
$B_2 \times C_2$ = 18,943 = (D_2)
$B_3 \times C_3$ = 11,402 = (D_3)
$B_4 \times C_4$ = — = (D_4)
TOTAL = # 60,029 = (D_T)

STEP 5. COMPUTE NET BENEFITS.

NET BENEFITS = $B_{NET} = D_T - TC$ = # 60,029 - # 58,967 = # 1062

Figure 6.2. Worksheet for alternative 1

Alternative No. 2

RECREATION AREA
Sanitary Facility Worksheet

	Direct Construction Cost (CC) ($)	Capital Cost (CAP) ($)	Amortized Capital Cost (AMC) ($/yr)	O&M Cost (AOM) ($/yr)	Average Annual Cost (AAC) ($/yr)
PROCUREMENT					
Water Purchase	—	—	—	720	720
TRANSMISSION					
(Included with distribution)	—	—	—	—	—
TREATMENT					
	—	—	—	—	—
STORAGE					
Tank	24,561	30,701	2,462	—	2,462
DISTRIBUTION					
Force Main	50,515	63,144	5,727	190	5,917
Pump Station	11,645	14,556	1,320	162	1,482
USE					
Washhouse	105,500	131,875	11,955	9,036	20,991
Comfort Station	54,769	68,461	6,206	5,899	12,106
COLLECTION					
Gravity Main	29,423	36,778	3,336	1,145	4,480
TREATMENT					
Package Plant	50,929	63,661	5,771	3,777	9,548
DISPOSAL	—	—	—	—	—
TOTALS	$327,342	$409,176	$36,777	$20,929	

Interest Rate 7 5/8 %

S&I ____ %

E&D ____ % } 25 %

Base Year 1980

Design Life 50

Total Sanitary Cost (AAC, $/yr) $57,706 = TC

Estimated Use (USE, use-units/yr) 39,990 rec days/yr

Unit Price ($/use-unit)

Figure 6.3. Cost sheet for alternative 2

FIXTURE AND TREATMENTS	TENTERS	CAMPERS AND TENT TRAILERS	MOTOR HOMES & TRAVEL TRAILERS	DAY USERS
TOILET	$2,087	$2,010	$1,708	$___
SHOWER	1,391	1,396	1,278	___
WASHBASIN	657	659	526	___
MIRROR	248	342	269	___
LAUNDRY SINK	194	152	242	___
INTERIOR (Low)	55	68	62	___
EXTERIOR (Low)	51	90	14	___
TOTAL WORTH	$4,683($C_1$)	$4,717($C_2$)	$4,099($C_3$)	$___($C_4$)

(4) Total value per year

$$D_T = (B_1 \times C_1) + (B_2 \times C_2) + (B_3 \times C_3) + (B_4 \times C_4)$$
$$= (6.192 \times \$4,683) + (3.999 \times \$4,717) + (2.709 \times \$4,099) + (0)$$
$$= \$28,977 + \$18,863 + \$11,104 + 0$$
$$= \$58,964$$

(5) Net benefits

$$B_{net} = D_T - TC$$
$$= \$58,964 - \$57,706$$
$$= \$1,258$$

A summary of all benefits for alternative 2 is provided on the benefit worksheet in Figure 6.4

Alternative 3: Two comfort stations with low architectural treatment

6.6 The architectural treatment used in this example will be the same as in alternative 2.

a. Costs. Costs will once again remain the same on all but the comfort stations. These costs are summarized in Figure 6.5.

b. Benefits. Benefits for alternative 3 are calculated as follows:

(1) Total Visitation (A)

See paragraph 6.4b(1).

(2) Visitation by Equipment Type (B)

See paragraph 6.4b(2).

(3) Values per 1000 party days

ALTERNATIVE 2

WORKSHEET A. WATERFLUSH SYSTEMS

STEP 1 ESTIMATE TOTAL VISITATION PER YEAR

PARTY DAYS PER YEAR 39,990 REC DAYS ÷ 3.1 AVG.PARTY SIZE= 12,900 (A)

STEP 2 ESTIMATE VISITATION BY EQUIPMENT TYPE

TENTERS (THOUSANDS) 48 % x 12,900 (A) ÷ 1000 = 6.192 (B_1)

CAMPERS AND TENT TRAILERS (THOUSANDS) 31 % x 12,900 (A) ÷ 1000 = 3.999 (B_2)

MOTOR HOMES AND TRAVEL TRAILERS (THOUSANDS) 21 % x 12,900 (A) ÷ 1000 = 2.709 (B_3)

DAY USERS 0 % x 12,900 (A) ÷ 1000 = — (B_4)

STEP 3 ESTIMATE VALUE PER 1000 DAYS FOR DESIGN ALTERNATIVE BEING EVALUATED

FIXTURE AND TREATMENTS	TENTERS	CAMPERS AND TENT TRAILERS	MOTOR HOMES & TRAVEL TRAILERS	DAY USERS
TOILET	#2087	#2,010	#1,708	—
SHOWER	1,391	1,396	1,278	—
WASHBASIN	657	659	526	—
MIRROR	248	342	269	—
LAUNDRY SINK	194	152	242	—
INTERIOR (Low)	55	68	62	—
EXTERIOR (Low)	51	90	14	—
TOTAL WORTH	#4,683 (C_1)	#4,717 (C_2)	#4,099 (C_3)	— (C_4)

STEP 4. COMPUTE THE TOTAL VALUE PER YEAR FOR THE ALTERNATIVE DESIGN BEING EVALUATED

$B_1 \times C_1$ = #28,997 = (D_1)
$B_2 \times C_2$ = 18,863 = (D_2)
$B_3 \times C_3$ = 11,104 = (D_3)
$B_4 \times C_4$ = — = (D_4)
TOTAL = #58,964 = (D_T)

STEP 5 COMPUTE NET BENEFITS

NET BENEFITS $B_{NET} = D_T - TC$ = #58,964 − 57,706 = #1,258

Figure 6.4. Worksheet for alternative 2

Alternative No. 3

RECREATION AREA
Sanitary Facility Worksheet

	Direct Construction Cost (CC) ($)	Capital Cost (CAP) ($)	Amortized Capital Cost (AMC) ($/yr)	O&M Cost (AOM) ($/yr)	Average Annual Cost (AAC) ($/yr)
PROCUREMENT					
Water Purchase	—	—	—	720	720
TRANSMISSION					
(Included with Distribution)	—	—	—	—	—
TREATMENT					
	—	—	—	—	—
STORAGE					
Tank	24,561	30,701	2,462	—	2,462
DISTRIBUTION					
Force Main	50,515	63,144	5,727	190	5,917
Pump Station	11,645	14,556	1,320	162	1,482
USE					
2 Comfort Stations	109,538	136,922	12,413	11,798	24,211
COLLECTION					
Gravity Main	29,423	36,778	3,336	1,145	4,480
TREATMENT					
Package Plant	50,921	63,661	5,771	3,777	9,548
DISPOSAL					
	—	—	—	—	—
TOTALS	$276,611	$345,762	$31,029	$17,792	

Interest Rate 7 5/8 %

S&I ____ %

E&D ____ % } 25%

Base Year 1980 %

Design Life 50 %

Total Sanitary Cost (AAC, $/yr) $48,820 = TC

Estimated Use (USE, use-units/yr) 39,990 rec. days/yr

Unit Price ($/use-unit)

Figure 6.5. Cost sheet for alternative 3

The values per 1000 party days for alternative 3 are:

FIXTURE AND TREATMENTS	TENTERS	CAMPERS AND TENT TRAILERS	MOTOR HOMES & TRAVEL TRAILERS	DAY USERS
TOILET	$2,087	$2,010	$1,708	$ ___
SHOWER	--	--	--	___
WASHBASIN	657	659	526	___
MIRROR	248	342	269	___
LAUNDRY SINK	194	152	242	___
INTERIOR (Low)	55	68	62	___
EXTERIOR (Low)	51	90	14	___
TOTAL WORTH	$3,292($C_1$)	$3,321($C_2$)	$2,821($C_3$)	___(C_4)

(4) Total value per year

$$D_T = (B_1 \times C_1) + (B_2 \times C_2) + (B_3 \times C_3) + (B_4 \times C_4)$$
$$= (6.192 \times \$3,292) + (3.999 \times \$3,321) + (2.709 \times \$2,821) + (0)$$
$$= \$20,384 + \$13,283 + \$7,642$$
$$= \$41,307$$

(5) Net Benefits

$$B_{net} = D_T - TC$$
$$= \$41,307 - \$48,820 = -\$7,513$$

A summary of all benefits for alternative 3 is provided on the benefit worksheet in Figure 6.6.

Conclusions

6.7 A comparison of the result of analyses for all alternatives is given in Table 6.1.

Table 6.1: ALTERNATIVE COMPARISONS

Alternative	Washhouse	Comfort Station	Net Benefits
1	1 (high arch)	1 (high arch)	+ $1,062
2	1 (low arch)	1 (low arch)	+ $1,258
3		2 (low arch)	- $7,514

From this, it can be seen that alternative 3 is the least desirable since the net benefits are negative. Alternative 2 appears to be the

best choice for further development. It should be noted that, while these are not absolute costs and benefits, they do in fact give the planner/designer a basis for evaluating trade-offs between alternatives.

ALTERNATIVE 3

WORKSHEET A: WATERFLUSH SYSTEMS

STEP 1. ESTIMATE TOTAL VISITATION PER YEAR

PARTY DAYS PER YEAR = 39,990 REC. DAYS ÷ 3.1 AVG.PARTY SIZE= 12,900 (A)

STEP 2. ESTIMATE VISITATION BY EQUIPMENT TYPE

TENTERS (THOUSANDS) 48 % x 12,900 (A) ÷ 1000 = 6.192 (B_1)

CAMPERS AND TENT TRAILERS (THOUSANDS) 31 % x 12,900 (A) ÷ 1000 = 3.999 (B_2)

MOTOR HOMES AND TRAVEL TRAILERS (THOUSANDS) 21 % x 12,900 (A) ÷ 1000 = 2.709 (B_3)

DAY USERS 0 % x 12,900 (A) ÷ 1000 = 0 (B_4)

STEP 3. ESTIMATE VALUE PER 1000 DAYS FOR DESIGN ALTERNATIVE BEING EVALUATED

FIXTURE AND TREATMENTS	TENTERS	CAMPERS AND TENT TRAILERS	MOTOR HOMES & TRAVEL TRAILERS	DAY USERS
TOILET	$2,087	$2,010	$1,708	—
SHOWER	—	—	—	—
WASHBASIN	657	659	526	—
MIRROR	248	342	269	—
LAUNDRY SINK	194	152	242	—
INTERIOR(Low)	55	68	62	—
EXTERIOR(Low)	51	90	14	—
TOTAL WORTH	$3,292 ($C_1$)	$3,321 ($C_2$)	$2,821 ($C_3$)	— (C_4)

STEP 4. COMPUTE THE TOTAL VALUE PER YEAR FOR THE ALTERNATIVE DESIGN BEING EVALUATED.

$B_1 \times C_1$ = $20,384 = ($D_1$)

$B_2 \times C_2$ = 13,281 = (D_2)

$B_3 \times C_3$ = 7,642 = (D_3)

$B_4 \times C_4$ = — = (D_4)

TOTAL = $41,307 = ($D_T$)

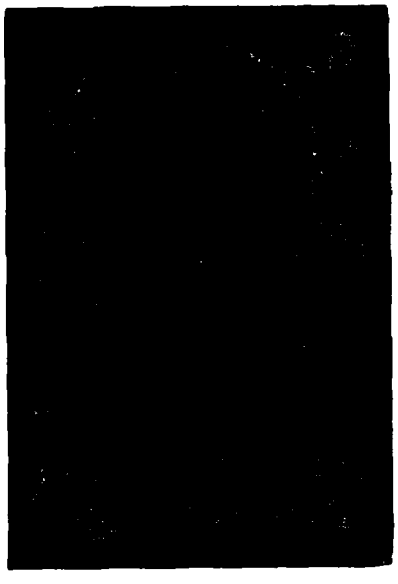
STEP 5. COMPUTE NET BENEFITS.

NET BENEFITS = $B_{NET} = D_T - TC$ $41,307 - 48,821 = -$7,514

Figure 6.6. Worksheet for alternative 3

APPENDICES

ARCHITECTURAL TREATMENTS



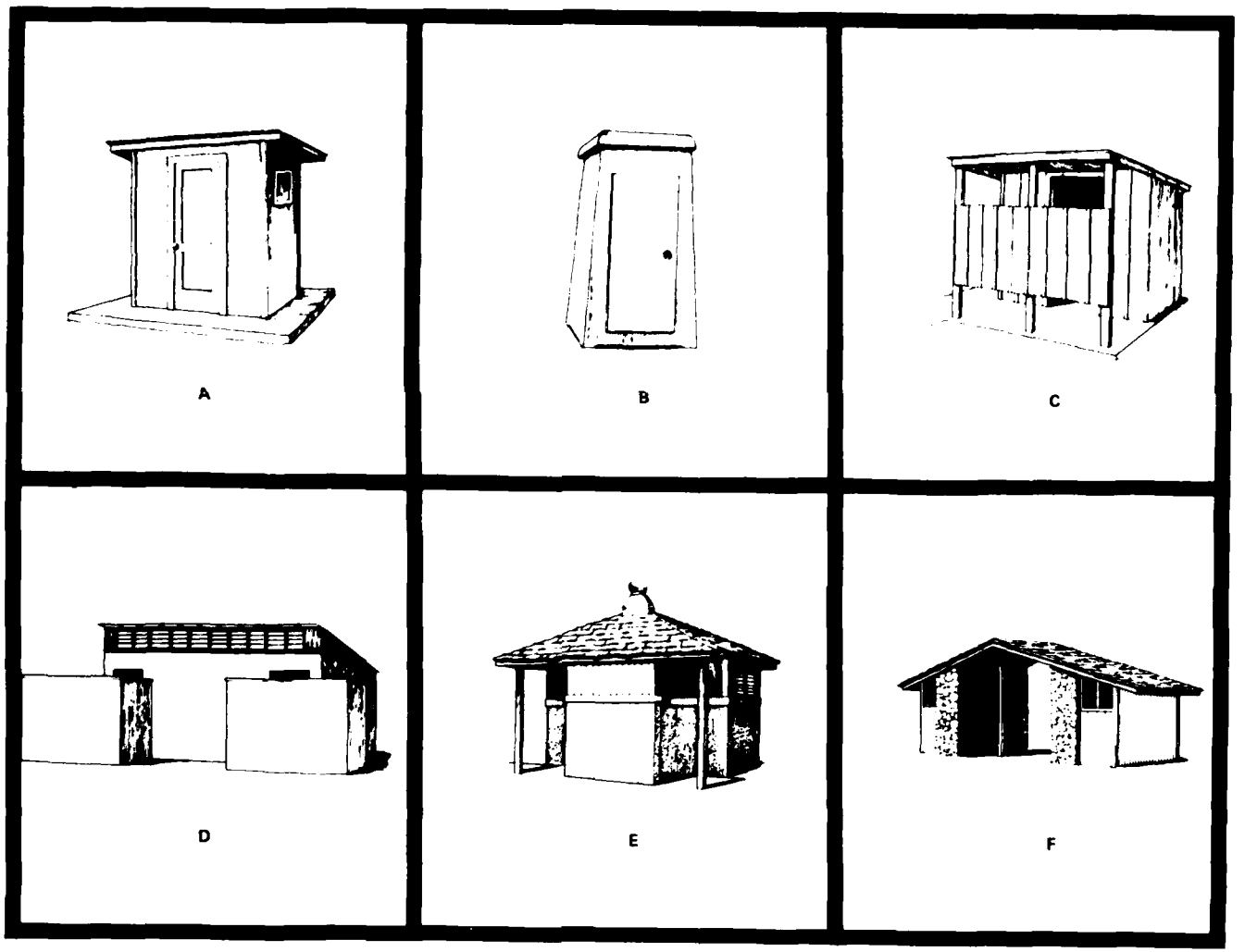


Figure 1. Low development exterior

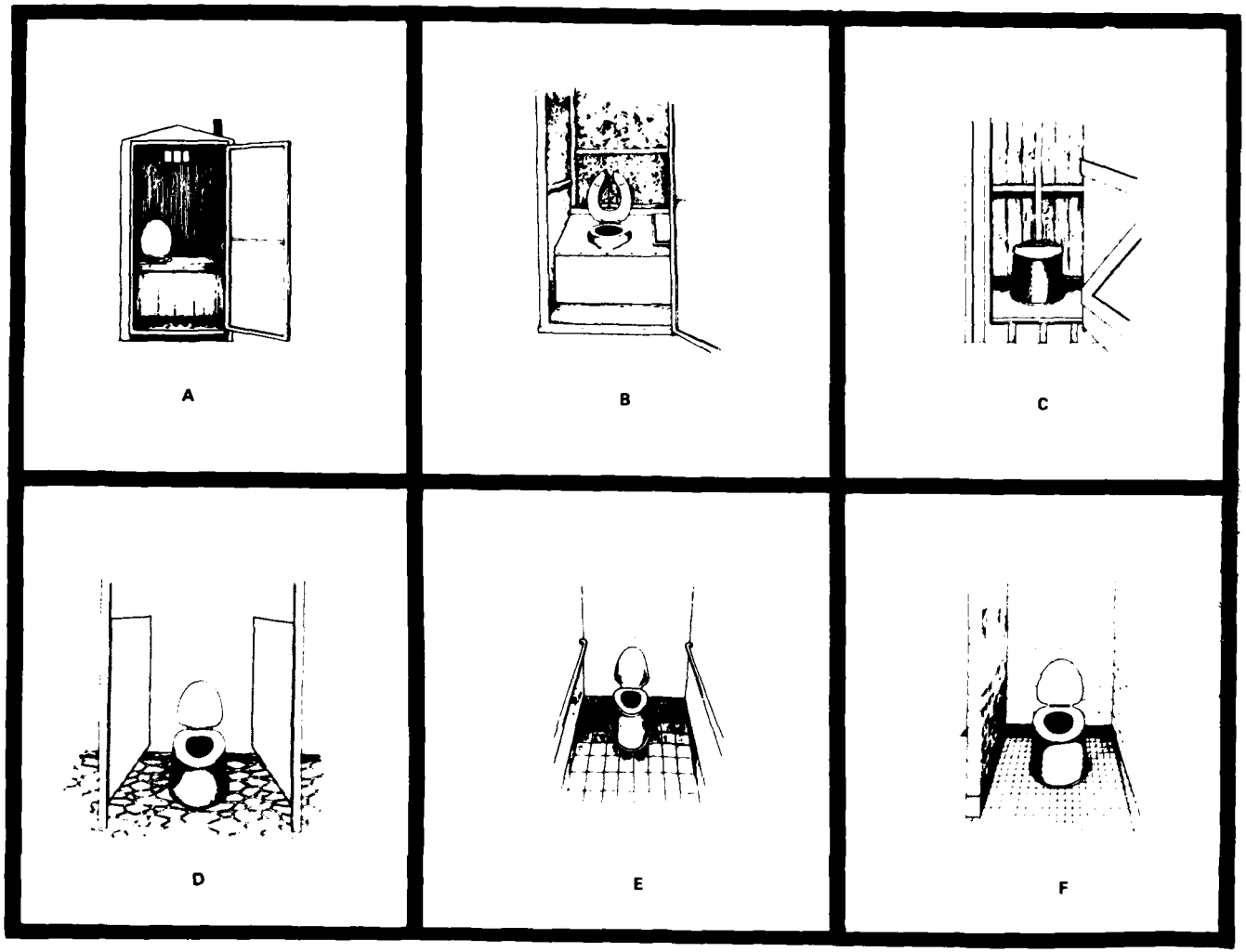


Figure 2. Low development interior

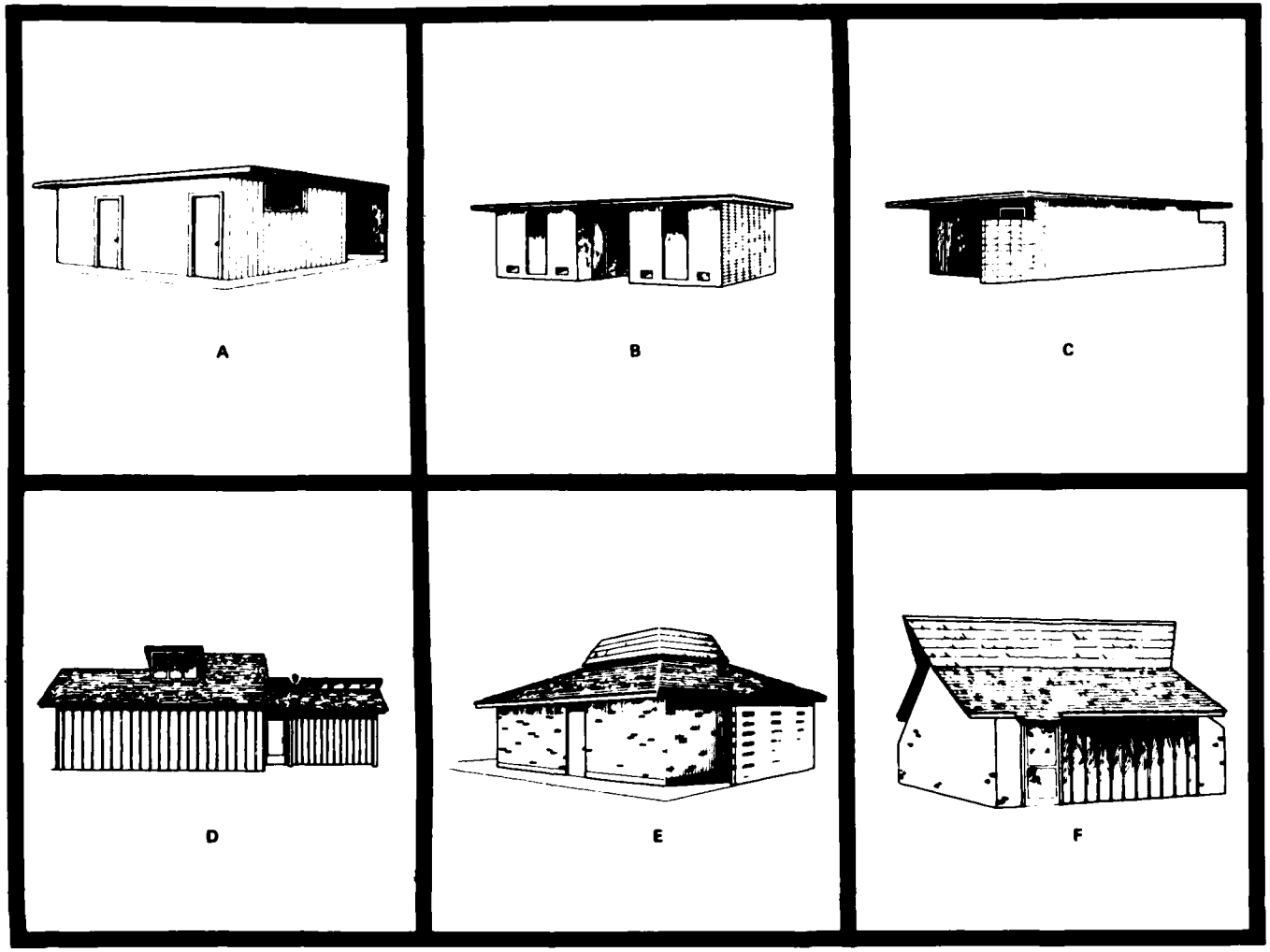


Figure 3. High development exterior

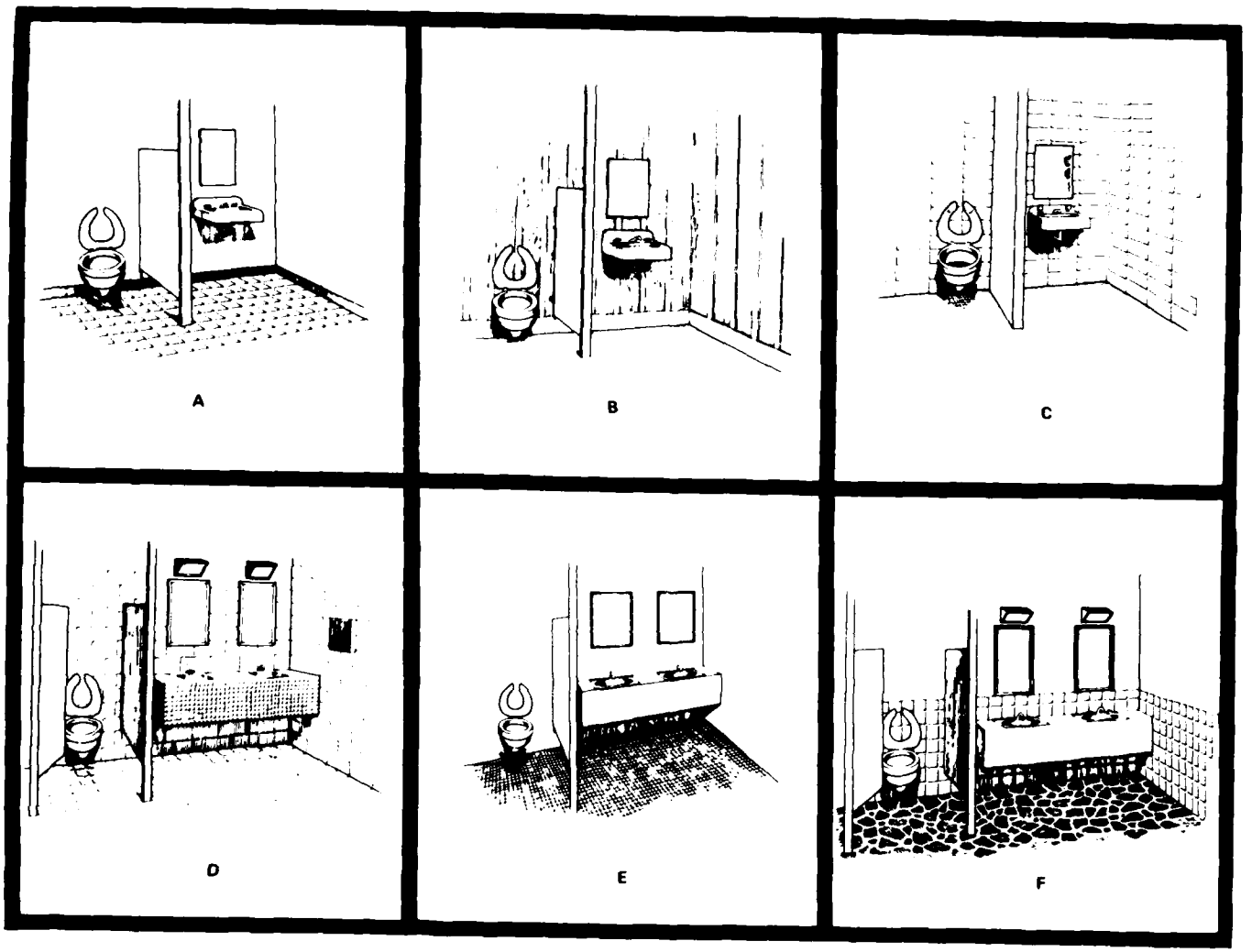
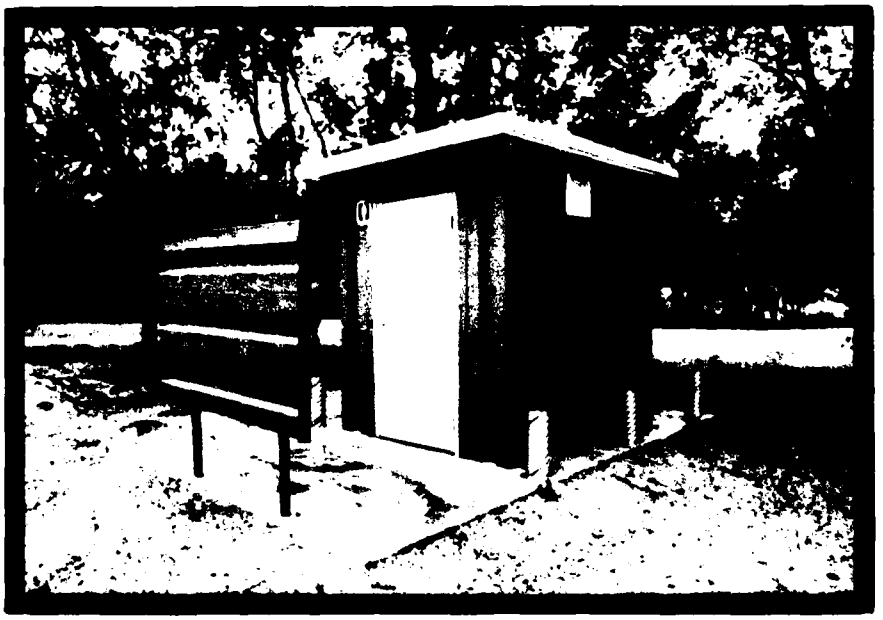


Figure 4. High development interior

BENEFITS WORKSHEET



ALTERNATIVE _____

WORKSHEET A: WATERFLUSH SYSTEMS

STEP 1. ESTIMATE TOTAL VISITATION PER YEAR

PARTY DAYS PER YEAR = _____ REC. DAYS ÷ _____ AVG.PARTY SIZE= _____ (A)

STEP 2. ESTIMATE VISITATION BY EQUIPMENT TYPE

TENTERS (THOUSANDS) _____ % x _____ (A) ÷ 1000 = _____ (B_1)

CAMPERS AND TENT TRAILERS (THOUSANDS) _____ % x _____ (A) ÷ 1000 = _____ (B_2)

MOTOR HOMES AND TRAVEL TRAILERS (THOUSANDS) _____ % x _____ (A) ÷ 1000 = _____ (B_3)

DAY USERS _____ % x _____ (A) ÷ 1000 = _____ (B_4)

STEP 3. ESTIMATE VALUE PER 1000 DAYS FOR DESIGN ALTERNATIVE BEING EVALUATED

FIXTURE AND TREATMENTS	TENTERS	CAMPERS AND TENT TRAILERS	MOTOR HOMES & TRAVEL TRAILERS	DAY USERS
TOILET				
SHOWER				
WASHBASIN				
MIRROR				
LAUNDRY SINK				
INTERIOR				
EXTERIOR				
TOTAL WORTH	(C_1)	(C_2)	(C_3)	(C_4)

STEP 4. COMPUTE THE TOTAL VALUE PER YEAR FOR THE ALTERNATIVE DESIGN BEING EVALUATED.

$B_1 \times C_1$ = _____ = (D_1)
$B_2 \times C_2$ = _____ = (D_2)
$B_3 \times C_3$ = _____ = (D_3)
$B_4 \times C_4$ = _____ = (D_4)
TOTAL = _____ = (D_T)

STEP 5. COMPUTE NET BENEFITS.

NET BENEFITS = $B_{NET} = D_T - TC$ = _____

ALTERNATIVE _____

WORKSHEET B: VAULT SYSTEMS

STEP 1. ESTIMATE TOTAL VISITATION PER YEAR

PARTY DAYS PER YEAR = _____ REC. DAYS ÷ _____ AVG. PARTY SIZE = _____ (A)

STEP 2. ESTIMATE VISITATION BY EQUIPMENT TYPE

TENTERS (THOUSANDS) _____ % x _____ (A) ÷ 1000 = _____ (B_1)

CAMPERS AND TENT TRAILERS (THOUSANDS) _____ % x _____ (A) ÷ 1000 = _____ (B_2)

MOTOR HOMES AND TRAVEL TRAILERS (THOUSANDS) _____ % x _____ (A) ÷ 1000 = _____ (B_3)

DAY USERS _____ % x _____ (A) ÷ 1000 = _____ (B_4)

STEP 3. ESTIMATE VALUE PER 1000 DAYS FOR DESIGN ALTERNATIVE BEING EVALUATED.

FIXTURE AND TREATMENTS	TENTERS	CAMPERS AND TENT TRAILERS	MOTOR HOMES & TRAVEL TRAILERS	DAY USERS
TOILET				
INTERIOR				
EXTERIOR				
TOTAL WORTH	(C_1)	(C_2)	(C_3)	(C_4)

STEP 4. COMPUTE THE TOTAL VALUE PER YEAR FOR THE ALTERNATIVE DESIGN BEING EVALUATED.

$B_1 \times C_1$ = _____ = (D_1)

$B_2 \times C_2$ = _____ = (D_2)

$B_3 \times C_3$ = _____ = (D_3)

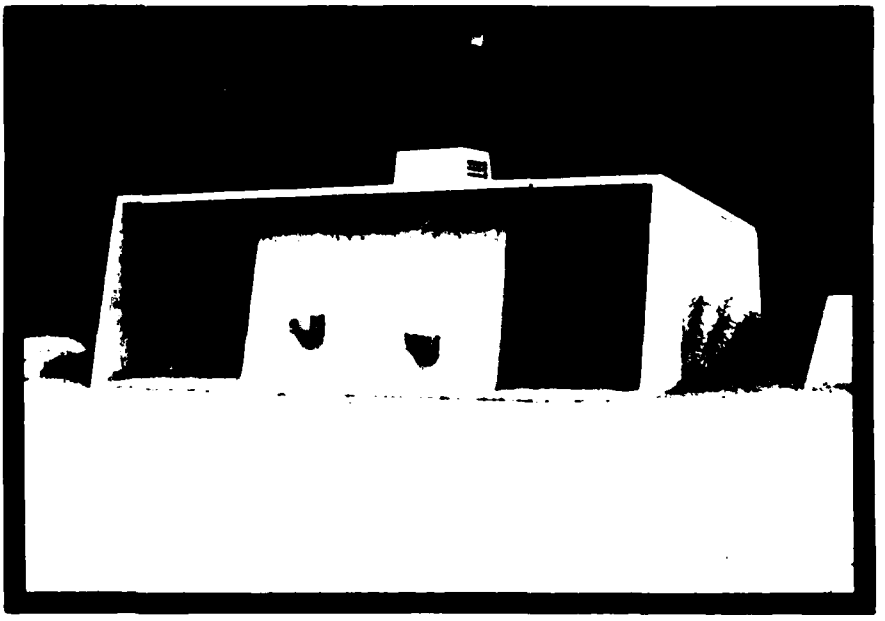
$B_4 \times C_4$ = _____ = (D_4)

TOTAL = _____ = (D_T)

STEP 5. COMPUTE NET BENEFITS.

NET BENEFITS = $B_{NET} = D_T - TC$ = _____

COSTS WORKSHEET



NOTE: FOR USE OF THIS WORKSHEET, PLEASE SEE EM 1110-2-401, "PLANNING LEVEL COST ESTIMATES AND SELECTION OF SANITARY FACILITIES AT RECREATIONAL AREAS"

Alternative No._____

RECREATION AREA
Sanitary Facility Worksheet

	Direct Construction Cost (CC) ($)	Capital Cost (CAP) ($)	Amortized Capital Cost (AMC) ($/yr)	O&M Cost (AOM) ($/yr)	Average Annual Cost (AAC) ($/yr)
PROCUREMENT					
TRANSMISSION					
TREATMENT					
STORAGE					
DISTRIBUTION					
USE					
COLLECTION					
TREATMENT					
DISPOSAL					
TOTALS					

Interest Rate _____%

S&I _____%

E&D _____%

Base Year _____%

Design Life _____%

Total Sanitary Cost (AAC, $/yr) [ ] = TC

Estimated Use (USE, use-units/yr)

Unit Price ($/use-unit)

In accordance with letter from DAEN-RDC, DAEN-ASI dated 22 July 1977, Subject: Facsimile Catalog Cards for Laboratory Technical Publications, a facsimile catalog card in Library of Congress MARC format is reproduced below.

Computing cost-effectiveness of alternative sanitary facilities / by Michael R. Waring ... [et al.] (Environmental Laboratory, U.S. Army Engineer Waterways Experiment Station). -- Vicksburg, Miss. : The Station ; Springfield, Va. : available from NTIS, 1983.
63 p. : ill. ; 27 cm. -- (Instruction report ; R-83-1)
Cover title.
"March 1983."
Final report.
"Prepared for Office, Chief of Engineers, U.S. Army."
At head of title: Recreation Research Program.

1. Cost effectiveness. 2. Recreation--costs. 3. Recreation areas--costs. 4. Sanitary engineering. 5. Sewage disposal. I. Waring, Michael R. II. United States. Army. Corps of Engineers. Office of the Chief of Engineers. III. Recreation Research Program.

Computing cost-effectiveness of alternative : ... 1983. (Card 2)

IV. Title V. Series: Instruction report (U.S. Army Engineer Waterways Experiment Station) ; R-83-1.
TA7.W34i no.R-83-1

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